

## APPENDIX C

# BONNEVILLE POWER ADMINISTRATION'S SYSTEM LOAD SHAPING GUIDELINES REGARDING TURBINE OPERATION AND BEST EFFICIENCY

## **Bonneville Power Administration's System Load Shaping Guidelines Regarding Turbine Operation and Best Efficiency**

**1. Background:** Outmigrating juvenile salmonids have several potential routes of passage past hydroelectric dams on the mainstem Columbia and Snake Rivers, including turbines, mechanical bypass, sluiceways, and spillways. Fish passage survival varies depending on the route of passage. As a result of reported higher mortality rates for fish passage through turbines (Iwamoto and Williams 1993), regional efforts have been focused on providing non-turbine passage routes for juvenile fish as a means to improve fish survival through the FCRPS. Nevertheless, substantial numbers of juvenile fish will continue to pass through turbines; therefore, effort to minimize turbine-related mortality is a priority of the fishery agencies and Indian Tribes, National Oceanic And Atmospheric Administration Fisheries (NOAA Fisheries, formerly National Marine Fisheries Service [NMFS]), U.S. Army Corps of Engineers (Corps), and Bonneville Power Administration (BPA).

Turbine operating efficiency has a relatively direct effect on fish passage survival; the relationship between survival of juvenile fish passing through Kaplan turbines is positively correlated and roughly linear to the efficiency at which the turbines are operated. Bell (1981) recommended making every effort to operate turbines at best efficiency at a given head during periods of peak fish passage to minimize fish mortality.

**2. Turbine Efficiency:** For the purposes of this document, best turbine efficiency operation shall be based on efficiency tables provided by the Corps for each project in the Fish Passage Plan (FPP). The Corps shall ensure that these efficiency ranges are based on the best available information, and that updates are coordinated with BPA, the Fish Passage Operation and Maintenance Coordination Team, and operating agencies. The tables will be distributed to all operating agencies prior to implementation, allowing at least two working days after receipt of the tables for implementation.

Operating efficiency of turbines is a result of wicket gate opening and blade angle for a given head (Bell 1981). As a result, there is a family of turbine efficiency curves for each project (or turbine design) for various head differentials. Operational decisions affecting turbine operations are based on

efficiency curves for incremental changes in head, as provided by turbine manufacturers or empirical testing.

### **3. Guidelines:**

a. Objective: To reduce the mortality of outmigrating juvenile salmonids, BPA will provide the Corps' hydrosystem projects with generation requests that allow turbines at the Lower Snake (LSN) and Lower Columbia (LCOL) projects to operate within 1% of best efficiency, or as otherwise specified, during the Best Efficiency Operating Period, within the guidelines outlined below.

b. Best Efficiency Operating Period: This period is defined as 24 hours per day from April 1 through October 31 for all LCOL river and LSN river projects. BPA will maintain generation requests that allow turbines to operate within 1 percent of best efficiency in accordance with these guidelines however, operation may occur outside 1% of best efficiency subject to the limitations listed in paragraphs 4 and 5.

Reporting generation requests outside the 1% best efficiency range relative to the applicable best efficiency limitations during the Best Efficiency Operating Period will be provided as outlined in paragraph 6.

c. Unit Priorities: The Corps should make every effort to adhere to unit priorities. The Corps shall follow a unit priority list that specifies which units at each LSN and LCOL project should be operated within the range of best efficiency, to minimize impact to salmon stocks. Likewise, the Corps will also indicate the priority for operating units outside the 1% best efficiency minimum or maximum ranges. The list will be based on the best available fish passage and turbine efficiency information and will be included in the FPP.

d. Project Priorities: If units must be operated out of the 1% best efficiency range, then BPA will make every effort to assure that generation requests to the Corps projects adhere to project priorities. Project priority may be developed weekly, based on in-season fish passage information, by the Technical Management Team (TMT).

e. Coordination: Coordination will occur through existing interagency coordinating mechanisms, such as the Corps, BOR, BPA and NOAA Fisheries in-season management process described in the NMFS 2000 BiOp.

Coordination is also intended to minimize frequent disruption of FCRPS by allowing the action agencies sufficient lead time to include system operational changes in their planning activities. Sufficient time is defined as a minimum of two working days before implementation, unless an emergency situation exists. In the event of an emergency, implementation will begin as soon as practical given concurrent operations, hydraulic situations and loads.

Reasonable and prudent operation outside of best efficiency for limitations listed in paragraphs 4.a and 4.b is at the discretion of the BPA and Corps. BPA and the Corps will coordinate with NOAA Fisheries when operation of turbines outside of the best efficiency range may be appropriate under provisions in paragraphs 4.c through 4.i. Coordination will occur during the bi-weekly TMT meetings.

Emergency situations, described in paragraphs 4.a and 4.b, that require an immediate change in FCRPS operation to avoid excessive take of listed salmonids may be directly coordinated at any time between NOAA Fisheries and the action agencies. Coordination of an emergency change in FCRPS operation shall normally be completed immediately, with information supplied to the TMT described above as soon as practical. Implementation of the change(s) will occur as soon as practical given operational, hydraulic and load conditions. The action agencies shall provide points of contact to allow such emergency coordination to occur.

#### **4. Limitations for the period April 1 through October 31.**

Conditions that may affect BPA's ability to operate in such a manner include:

a. System Reliability: BPA's ability to operate the power system in a manner that enables the Corps to maximize operation of turbines within best range will be constrained by requirements to maintain system reliability (including requirements necessary for transient and voltage stability of the transmission system), and the ability to meet system response criteria. Additionally, it is necessary to maintain a margin of resource generation on line to fulfill Northwest Power Pool (NWPP), Western Electricity Coordinating Council (WECC), and the North American Electric Reliability Council (NERC) reliability requirements.

BPA's Reliability Criteria for Operations<sup>1</sup>, the Northwest Power Pool Operating Manual<sup>2</sup>, the Western Systems Coordinating Council Operations Committee Handbook<sup>3</sup>, and the North American Electric Reliability Council Operating Manual<sup>4</sup> define system response criteria and margin of resource generation.

Predictable instances of deviation from within the best range as a consequence of prudent utility operation for control of short-term system dynamics include:

1) Routine responses to loss of generation, load or transmission within the interconnection including delivery of Operating Reserve Obligation to NWPP members upon request. The duration of these deviations is minimal, but dependent upon recovery by the interconnection member with the problem.

2) Routine starting and stopping of generation units. These deviations are unavoidable, but very short in duration.

3) Deliberate dropping of generation, i.e., instantaneous interruption of output, to preserve system integrity. This dropping could cause a brief excursion.

b. Firm and Direct Service Industry (DSI) Load: The LCOL and LSN projects will be operated within 1% of best efficiency to the extent that the ability to meet firm loads is not jeopardized. According to the Regional Act, the Power Sales Contract<sup>5</sup> with the DSIs and House Report 96-976<sup>6</sup>, dated September 16, 1980," the total DSI load will be considered firm for purposes of resource operation."

c. Total Dissolved Gas Supersaturation (TDG): The TDG levels will be monitored at each project during the fish passage season. Signs of gas bubble disease will be monitored at all Smolt Monitoring Program sampling sites and selected in-river sites. Best turbine efficiency operation may be modified if representative monitoring data indicate that TDG is affecting fish survival. Necessary operational modifications will be coordinated through the process outlined in paragraph 3.e.

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<sup>1</sup>Section 4.

<sup>2</sup>Minimum Operating Reliability Criteria Sections I and II. 1.-3. and 8.

<sup>3</sup>Minimum Operating Reliability Criteria Section II 1.-4. and 8., and Section III 1.1 and 1.2.

<sup>4</sup>The entire manual has relevance. However, particularly concise portions are - Guide II.A. and the Reliability Criteria for Interconnected Systems Operation, especially the Preamble, Section I.A., B., and C., Section II.A. and B., and Section III.A.

<sup>5</sup>Section 8.(a).(1)

<sup>6</sup>Part II, page 48

d. Coordinated Fishery Operations: In the event that coordinated fishery operations and approved fishery research are not in accord with operating turbines at best efficiency, operational modifications will be coordinated through the process outlined in paragraph 3.e.

e. Grand Coulee (GCL) and Chief Joseph (CHJ) Flexibility: Within system reliability and firm load limitations, flexibility at GCL and CHJ will be fully used, whenever possible, before generation requests to LCOL and LSN projects are outside the best efficiency range.

f. Flow Augmentation Operations: Flow augmentation requests for LCOL flows at McNary (MCN) are primarily met by water releases from GCL. The decision on whether to use GCL flexibility to provide inflows to MCN at the level necessary to meet the week's LCOL flow request when fish collection is maximized for transport during the flow augmentation period shall be made through the coordination process outlined in paragraph 3.e.

The TMT flow augmentation requests may exceed the 1% best efficient operation range at LCOL/LSN projects. Meeting this flow request will take precedent over best efficient operations. Coordination of the implementation of the flow requests will occur through the process outlined in paragraph 3.e.

g. Transport Projects: Resolution of the conflict between spill management and turbine operation within 1% of best efficiency at transport projects during the transport season shall be determined through the coordination process outlined in 3.e., and in accordance with fish transportation guidelines, based on in-season flow and fish passage information. Care should be taken during transition periods close to the upper flow boundary to avoid frequent switching of priorities between spill and generation.

h. Routine Maintenance and Testing: All units at all projects must undergo maintenance and associated testing. The testing necessitates deviation from the 1% best efficiency band for periods of from 15 minutes to 8 hours. Scheduling of maintenance testing will be coordinated through the process outlined in 3.e., to ensure that it is conducted during times of low fish passage within a day to minimize impacts on fish.

i. Flood Control: The FCRPS provides multiple benefits to the region. Flood control is the primary function of many of the projects on the Columbia River. In the event that river flow conditions require flood control operations, operation of turbines within the 1% best efficiency range may be modified or suspended based on the Corps' direction. Allowing excursions from 1% best efficiency for flood control operations would facilitate transportation, reduce excessive dissolved gas levels, and lower the risk of gas bubble disease in fish. Coordination of flood control operations will occur as outlined in paragraph 3.e. See also paragraphs 4.c and 4.e.

During flood control operation, compliance reporting will follow procedures outlined in paragraph E.

j. Other: In the event that the excursion was not explainable or caused by human error.

**5. Limitations for the period September 1 through October 31:** Conditions that may affect BPA's ability to operate in such a manner include all limitations in 4.a. through 4.j., plus the requirement for prudent use of the FCRPS storage capability necessary to import energy into the FCRPS for fish storage and firm load requirements.

**6. Quality Control:** Significant deviations from 1% will be reported to the TMT. Data on unit status will be kept by BPA during the 1% operating season. Documentation as to why the excursions occurred will be kept in project logs at each dam.

Upon request of the TMT, a case-by-case brief explanation of the reason(s) for unit operation outside the best efficiency range, the date, and the associated period of time will be provided by the appropriate parties.

A brief explanation of the reason(s) for unit operation outside the best efficiency range, the date, and the associated period of time will also be provided for documented excursions. Other excursions (e.g., excursions for unknown reasons) will also be reported.